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STONE & WEBSTER ENGINEERING CORPORATION

CONSTRUCTING ENGINEERS

WATER POWERS

417
S88

Stone & Webster engineering corporation, Boston

WATER POWERS

SNOQUALMIE NOOKSACK PUYALLUP BIG CREEK
GOAT ROCK TAYLORS FALLS FRANKLIN VERDI
WHITE SALMON HAUSERLAKE EAST TILTON WHITE RIVER

UNIV. OF CALIFORNIA

TS4
S7

STONE & WEBSTER ENGINEERING CORPORATION

CONSTRUCTING ENGINEERS

Water Power Developments *Transmission Lines* *Steam Power Stations*
Electric Railway and Steam Railroad Work *Gas Plants*
Industrial Plants and Buildings of Steel or Reinforced Concrete

BOSTON, MASSACHUSETTS

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CALIFORNIA

NEW YORK **CHICAGO** **SEATTLE** **DALLAS**

PLATE INDEX

LOW HEAD PLANTS (Below 100 Feet)

Names	Constructed for	Plates
Taylors Falls	*Minneapolis General Electric Company*	1–5
Hauserlake Dam	*United Missouri River Power Company*	6, 7, 8
Franklin (N.H.)	*Boston & Maine Railroad Company*	9, 10, 11
East Tilton (N.H.)	*Laconia Gas & Electric Company*	12, 13, 14
Verdi	*Truckee River General Electric Company*	15, 16, 17
Goat Rock	*Columbus (Ga.) Power Company*	18–21

MEDIUM HEAD PLANTS (100 to 500 Feet)

Name	Constructed for	Plates
Nooksack	*Whatcom County Railway & Light Company*	22
Snoqualmie 2d Plant	*Seattle-Tacoma Power Company*	23, 24
White River	*Pacific Coast Power Company*	25–32
White Salmon	*Northwestern Electric Company*	33–36

HIGH HEAD PLANTS (Over 500 Feet)

Name	Constructed for	Plates
Puyallup or Electron	*Puget Sound Power Company*	37–41
Big Creek	*Pacific Light and Power Corporation*	42–45

262765

LOW HEAD PLANTS

Name	*Constructed for*
Taylors Falls . .	*Minneapolis General Electric Co.*
Hauserlake Dam .	*United Missouri River Power Co.*
Franklin (N. H.) . .	*Boston & Maine Railroad Co.*
East Tilton (N. H.) . .	*Laconia Gas & Electric Co.*
Verdi	*Truckee River General Electric Co.*
Goat Rock	*Columbus (Ga.) Power Co.*

Taylors Falls

(Low Head)

Location . . .	*St. Croix River, 40 miles northeast of Minneapolis, Minnesota.*
Capacity . . .	*20,000 Electrical Horse Power installed. 30,000 Horse Power ultimate.*
Head	*50 Feet.*
Power House .	*Concrete, forming part of dam, 200 ft. × 82 ft.*
Dam	*Concrete, solid gravity type, 640 ft. long on the spillway, 53 ft. high.*
Generating Equipment	*Four 4200 H.P. Platt Iron Works turbines. direct-connected to four 2500 K.W., 2300-volt, 3-phase, Westinghouse generators and two 4200 H.P. Wellman-Seaver-Morgan turbines, direct-connected to two 2500 K.W., 2300-volt, 3-phase, General Electric generators.*
Transformers .	*Nineteen 900 K.W., 2300/50,000-volt, single phase, water cooled.*
Transmission Lines	*Two 50,000-volt, 3-phase lines, each 40 miles long, connecting with Minneapolis substation.*
Use of Power .	*Light and power.*
Operating Company	*Minneapolis General Electric Co.*

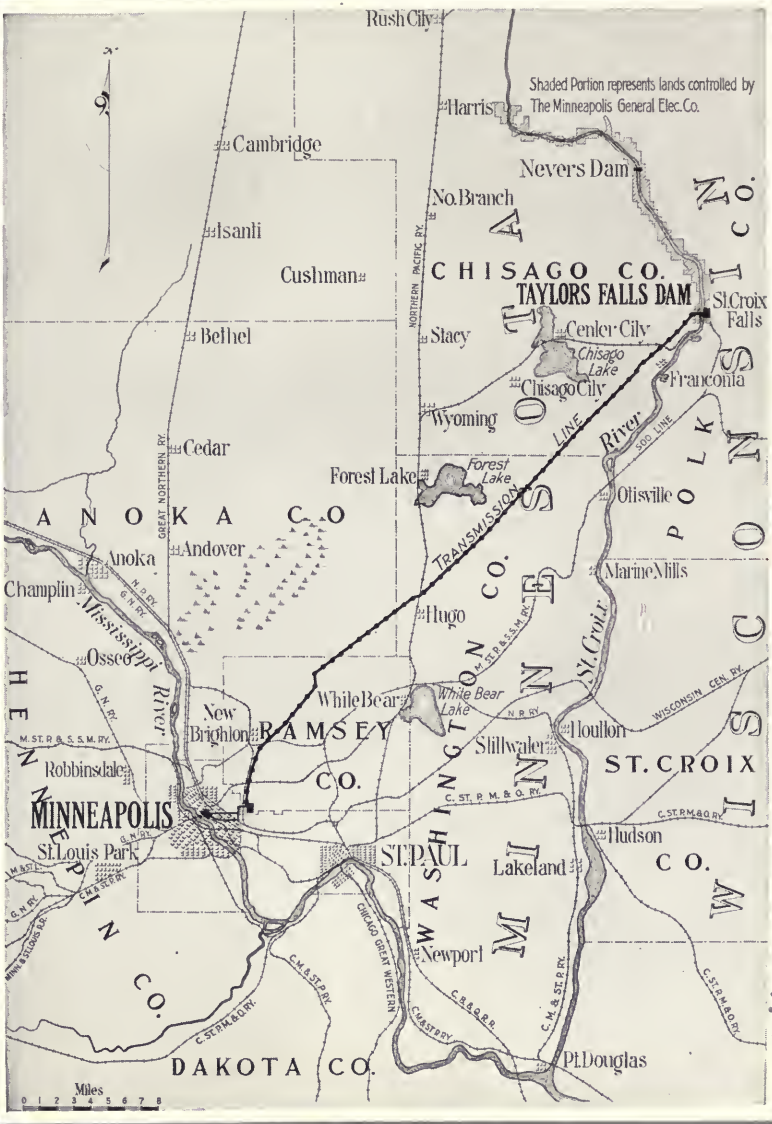
Shaded Portion represents lands controlled by The Minneapolis General Elec. Co.
Rush City
Harris
Nevers Dam
Cambridge
No. Branch
Isanti
Cushman
CHISAGO CO.
TAYLORS FALLS DAM
St. Croix Falls
Center City
Chisago Lake
Chisago City
Franconia
Bethel
Stacy
Wyoming
Cedar
Forest Lake
Forest Lake
Olisville
ANOKA CO.
Andover
Anoka
Champlin
Mississippi River
Marine Mills
Hugo
Osseo
White Bear
White Bear Lake
New Brighton
RAMSEY CO.
Stillwater
Houlton
Robbinsdale
MINNEAPOLIS
St. Louis Park
ST. PAUL
Lakeland
Hudson
Newport
Pt. Douglas
DAKOTA CO.
HENNEPIN CO.
WASHINGTON CO.
MINNESOTA
WISCONSIN
ST. CROIX CO.
POLK CO.
TRANSMISSION LINE
St. Croix River
NORTHERN PACIFIC RY.
GREAT NORTHERN RY.
N. P. RY.
G. N. RY.
M. ST. P. & S. S. M. RY.
C. ST. P. M. & O. RY.
C. M. & ST. P. RY.
C. & N. W. RY.
CHICAGO GREAT WESTERN
WISCONSIN CEN. RY.
SOO LINE
Miles
0 1 2 3 4 5 6 7 8

PLATE 1

DAM AND F

ER HOUSE

TAYLORS FALLS

PLATE 2 SPILLWAY FROM POWER HOUSE TAYLORS FALLS

TAYLORS FALLS GENERATOR ROOM PLATE 3

PLATE 4 TRANSMISSION

LINES TAYLORS FALLS

TAYLORS FALLS SUB-STATION "A," MINNEAPOLIS PLATE 5

Hauserlake Dam (*Low Head*)

Location . .	*Missouri River, 18 miles northeast of Helena, Montana.*
Capacity . .	*18,600 Horse Power.*
Head . . .	*65 Feet.*
Storage . .	*91,800 Acre Feet.*
Dam . . .	*Solid gravity type, 490 ft. long, 132 ft. high at its deepest part, 85 ft. thick at the base, contains 85,000 yards of concrete.*
Operating Company	*United Missouri River Power Co.*

Hauserlake booklet, supplied on request, describes work in detail.

HAUSERLAKE SPILLWAY FROM EAST BANK PLATE 6

PLATE 7 DAM AND LAKE FROM EAST BANK HAUSERLAKE

HAUSERLAKE FROM THE CLIFFS ON WEST BANK PLATE 8

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Franklin (*Low Head*)

Location . . .	*Franklin, N. H., on Pemigewasset River, 21 miles north of Concord.*
Capacity . .	*1600 Electrical Horse Power installed. 4000 Horse Power ultimate.*
Head	*30 Feet.*
Power House .	*Concrete and steel, 58 ft. × 71 ft.*
Dam	*Timber crib, 313 ft. long, 26 ft. high.*
Generating Equipment	*One 1727 Horse Power Leffel turbine direct-connected to 1000 K.W., 2200-volt, 3-phase, General Electric generator. Also a reconstructed Rodney Hunt turbine, 455 Horse Power direct-connected to 200 K.W., 2200-volt, 3-phase General Electric generator.*
Transformers .	*Six 333 K.W., 2200/22,000-volt, single phase, oil cooled.*
Transmission Lines	*21 miles of 22,000-volt line in duplicate, Franklin to Concord.*
Use of Power .	*Street railway, lighting and shop power.*
Operating Company	*Boston & Maine Railroad Company.*

FRANKLIN POWER HOUSE FROM EAST BANK PLATE 9

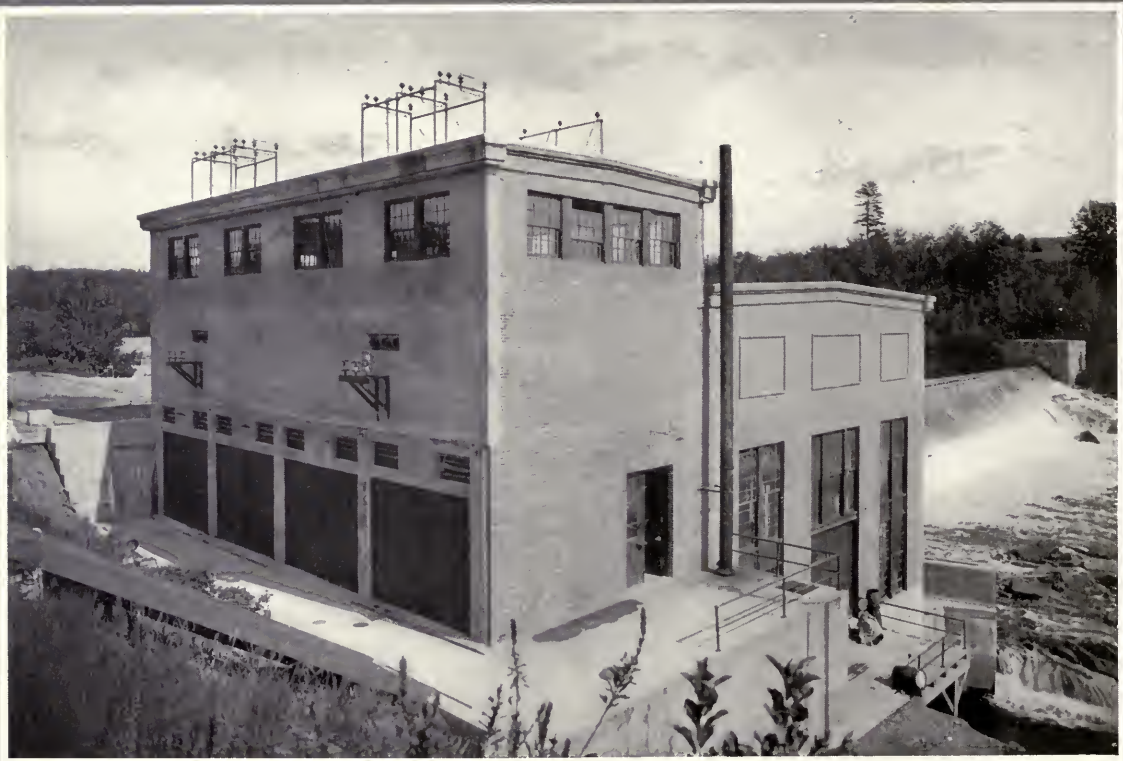
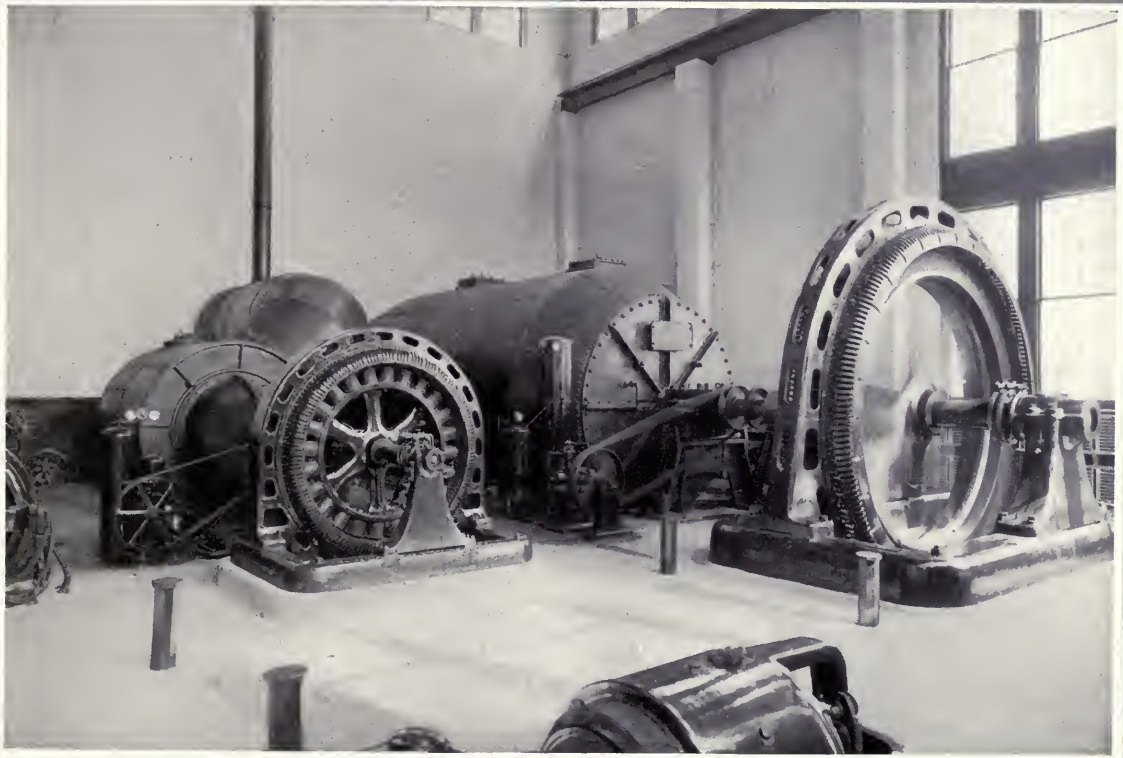


PLATE 10 POWER HOUSE FRANKLIN



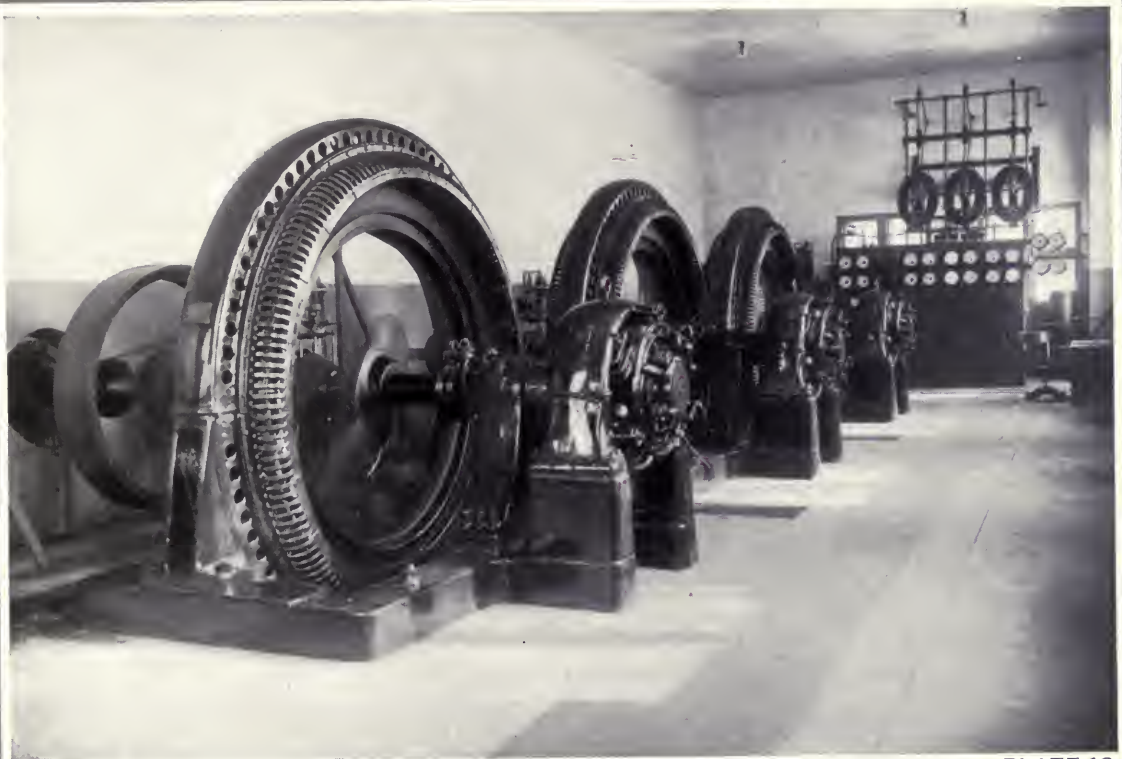
FRANKLIN GENERATOR ROOM PLATE 11

*East Tilton**

(Low Head)

Location . . .	*East Tilton, N. H., on the Winnepesaukee River, 6 miles southwest of Laconia.*
Capacity . .	*800 Electrical Horse Power installed. 1100 Horse Power ultimate.*
Head	*17 Feet.*
Power House .	*Reinforced concrete and tile, 73 ft. × 44 ft.*
Dam	*Masonry structure, faced and decked with concrete.*
Generating Equipment	*Three 340 H. P. Leffel turbines direct-connected to 200 K. W., 6600-volt, 3-phase Allis-Chalmers generators.*
Transmission .	*7 miles, 6600-volt, 3-phase, East Tilton to Lakeport.*
Use of Power .	*Railway, light and power.*
Operating Company	*Laconia Gas & Electric Co.*

**For map see Franklin Section*



EAST TILTON GENERATOR ROOM PLATE 12

PLATE 13 POWER HOUSE EAST TILTON

EAST TILTON DAM AND SPILLWAY PLATE 14

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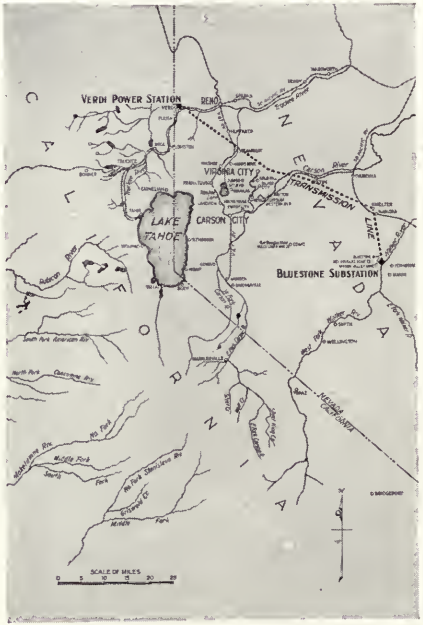
Verdi (*Low Head*)

Location . . .	*Truckee River, near Verdi, 12 miles west of Reno, Nevada.*
Capacity . . .	*3000 Electrical Horse Power.*
Head	*92 Feet.*
Power House .	*Brick, 47 ft. × 67 ft.*
Dam	*Rock filled, timber-crib and earth dam, 440 ft. long, 16 ft. high, 51 ft. wide.*
Pipe Lines and Canals	*Canal 2 miles long; 1426 ft. of 9 ft. wood stave pipe, 736 ft. of 7 ft. steel pipe.*
Generating Equipment	*One 3200 H.P. Allis-Chalmers turbine, direct-connected to 2250 K.W., 2250-volt, 3-phase, General Electric generator.*
Transformers .	*Four 1000 K.W., 2300/60,000-volt, 3-phase, water cooled.*
Transmission Line	*64 miles of 60,000-volt line in duplicate, Verdi to Bluestone.*
Use of Power .	*Light and power.*
Operating Company	*Truckee River General Electric Co.*



VERDI DIVERSION DAM AND HEADWORKS PLATE 15

PLATE 16 TRUCKEE RIVER ABOVE DAM SITE VERDI

VERDI POWER HOUSE PLATE 17

UNIV. OF CALIFORNIA

Goat Rock

(Low Head)

Location . . .	*Chattahoochee River, 14 miles north of Columbus, Georgia.*
Capacity . .	*8000 Electrical Horse Power installed. 40,000 Horse Power ultimate.*
Head	*70 Feet.*
Storage . . .	*3000 Acre Feet.*
Power House .	*Reinforced Concrete, forming part of dam, 114 ft. × 56 ft.*
Dam	*Concrete, solid gravity type, 68 ft. high, 910 ft. spillway.*
Generating Equipment	*Two 4800 H.P., S. Morgan Smith turbines, direct-connected to 3000 K.W., 12,000-volt, 3-phase Westinghouse generators.*
Transformers .	*Three 1066 K.W., 12,000/66,000 delta, 12,000/115,000 Y.*
Transmission Lines	*Goat Rock to Newnan — 60 miles, 66,000 volts, temporary. Line designed for 115,000 volts ultimate. Goat Rock to Columbus — 14 miles, 11,000 volts.*
Use of Power .	*Railway, light and power.*
Operating Company	*The Columbus Power Co.*

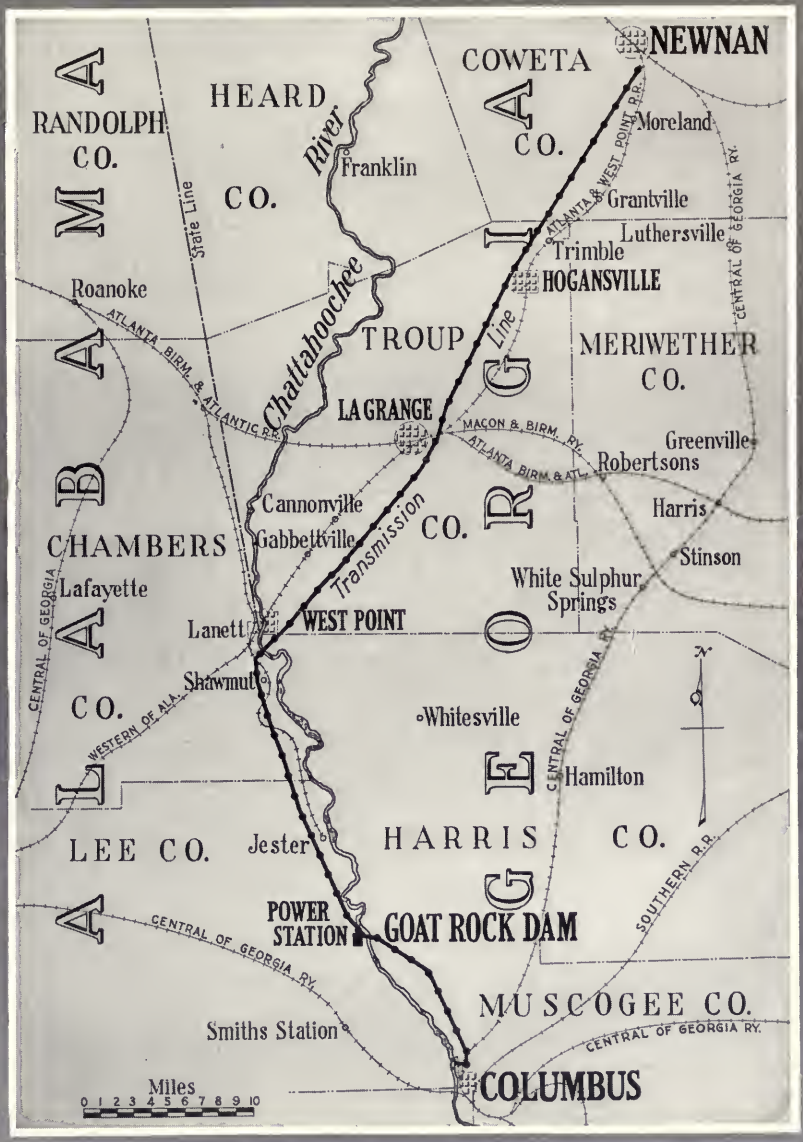
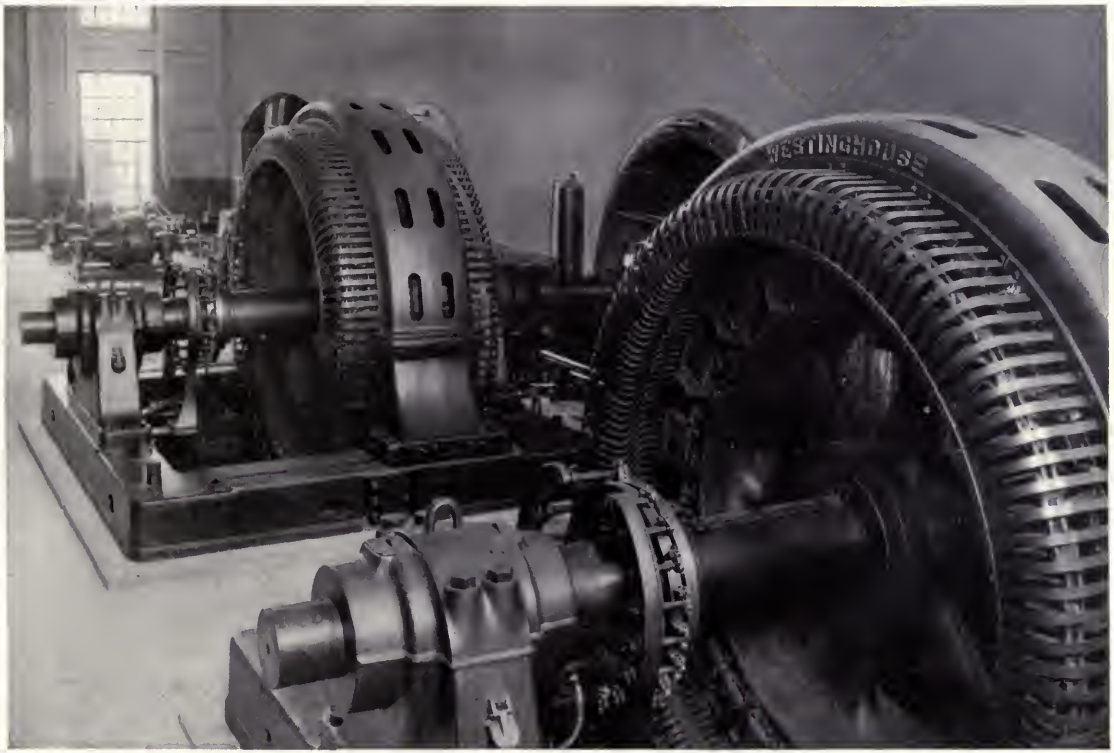
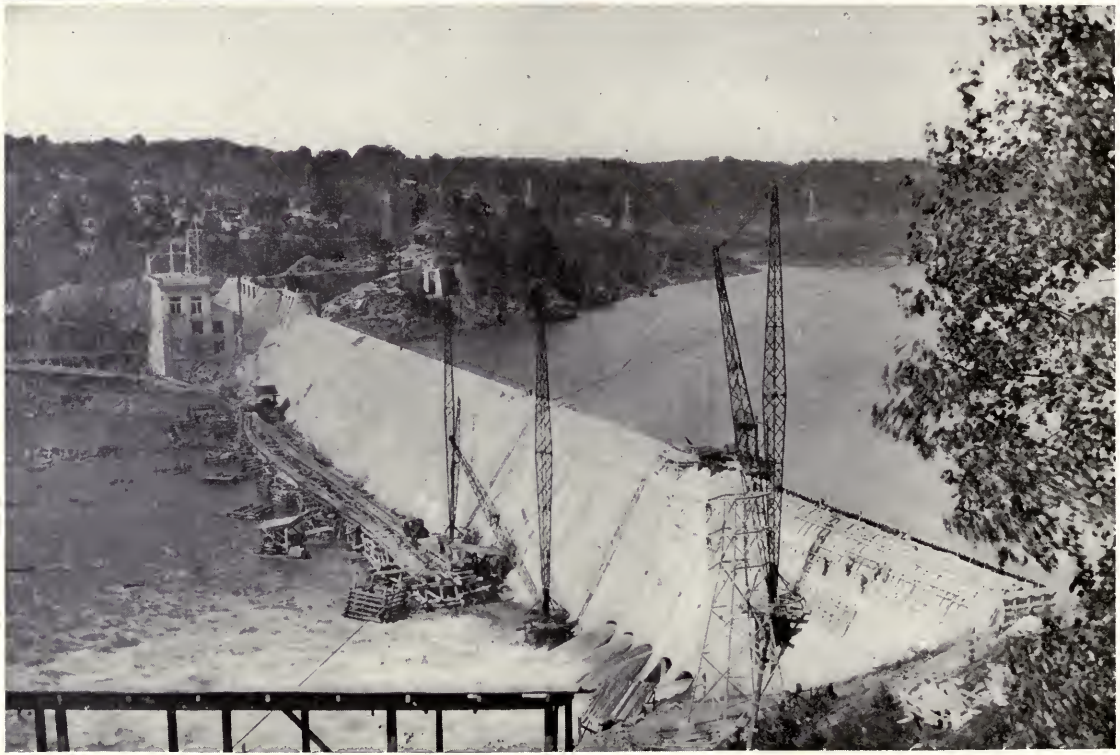

NEWNAN
COWETA
CO.
HEARD
CO.
RANDOLPH
CO.
ALABAMA
GEORGIA
Moreland
Franklin
River
Chattahoochee
State Line
Grantville
Luthersville
Trimble
HOGANSVILLE
ATLANTA & WEST POINT R.R.
CENTRAL OF GEORGIA RY.
Roanoke
ATLANTA BIRM. & ATLANTIC R.R.
TROUP
Line
MERIWETHER
CO.
LA GRANGE
MACON & BIRM. RY.
ATLANTA BIRM. & ATL.
Greenville
Robertsons
Harris
Stinson
Cannonville
Gabbettville
Transmission
CO.
CHAMBERS
Lafayette
White Sulphur
Springs
Lanett
WEST POINT
Shawmut
CO.
WESTERN OF ALA.
Whitesville
Hamilton
LEE CO.
Jester
HARRIS
CO.
SOUTHERN R.R.
POWER
STATION
GOAT ROCK DAM
CENTRAL OF GEORGIA RY.
MUSCOGEE CO.
Smiths Station
COLUMBUS
Miles
0 1 2 3 4 5 6 7 8 9 10

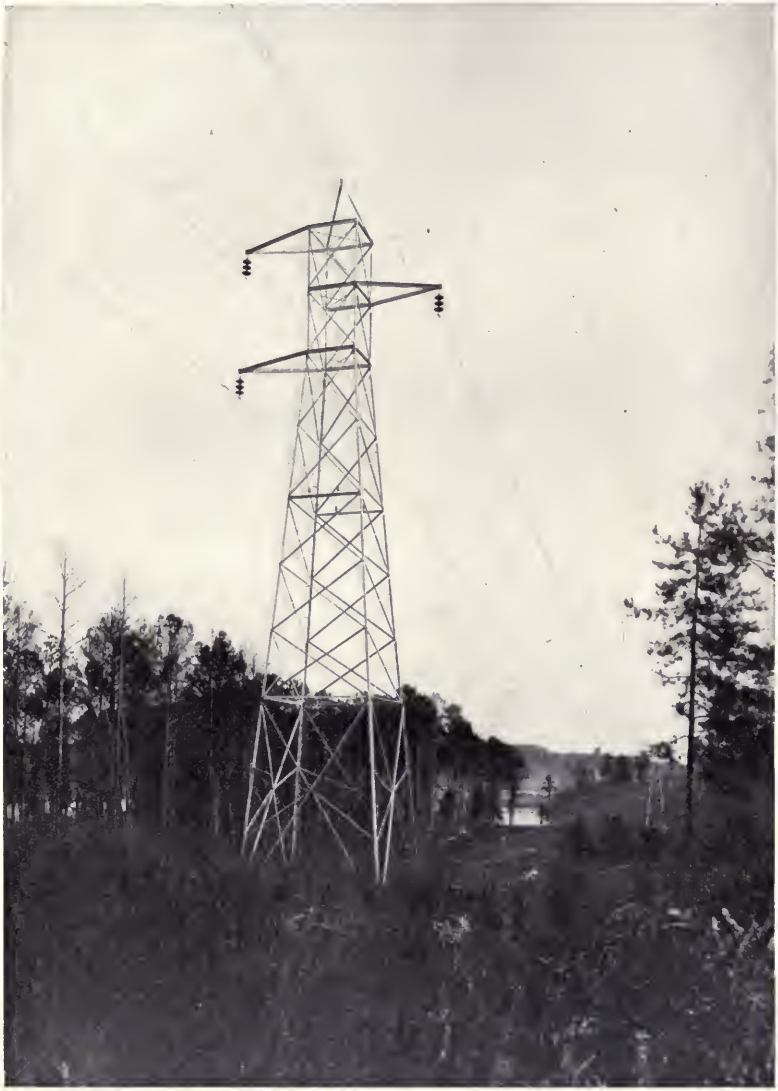
PLATE 18 POWER HOUSE GOAT ROCK



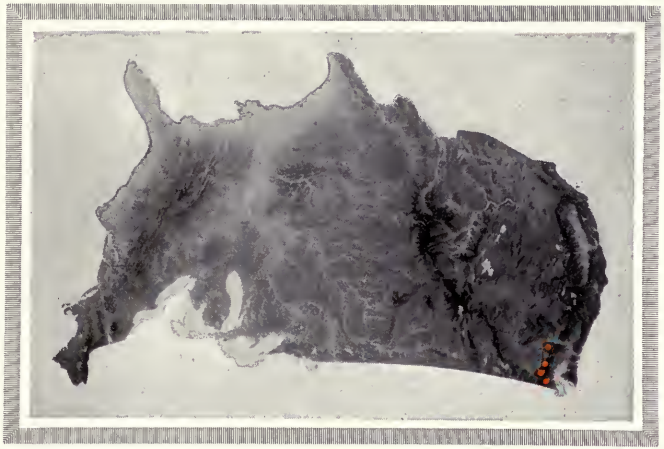
GOAT ROCK GENERATOR ROOM PLATE 19



GOAT ROCK FROM GEORGIA SHORE DURING CONSTRUCTION PLATE 20



GOAT ROCK TRANSMISSION LINE PLATE 21



UNIVERSITY OF CALIFORNIA

MEDIUM HEAD PLANTS

Name	*Constructed for*
Nooksack	*Whatcom County Railway & Light Co.*
Snoqualmie 2d Plant	*Seattle-Tacoma Power Co.*
White River	*Pacific Coast Power Co.*
White Salmon	*Northwestern Electric Co.*

Nooksack (*Medium Head*)

Location . . .	*North Fork, Nooksack River 40 miles east of Bellingham, Washington.*
Capacity . .	*2000 Electrical Horse Power installed. 5500 Horse Power ultimate.*
Head	*173 Feet, ultimate 420 Feet.*
Power House .	*Concrete, 57 ft. × 40 ft.*
Dam	*Diverting weir, rock filled, timber crib.*
Pipe Lines and Canals	*Wood stave pipe, 1300 ft. long, 44" diameter. Steel pipe, 1300 ft. long, 47" diameter.*
Generating Equipment	*Pelton water wheel, 3200 H.P. direct-connected to 1500 K.W., 3-phase 2200-volt Westinghouse generator.*
Transformers .	*Three 600 K. W., single phase, 2200/55,000-volt, self-cooled.*
Transmission Lines	*40 miles 55,000-volt line to Bellingham, Washington.*
Use of Power .	*Railway and light.*
Operating Company	*Puget Sound Traction, Light & Power Co., Bellingham Division.*

NOOKSACK POWER HOUSE PLATE 22

Snoqualmie Second Plant

(Medium Head)

Location . .	*Snoqualmie River, 30 miles east of Seattle, Washington.*
Capacity . .	*10,000 Electrical Horse Power installed. 30,000 Horse Power ultimate.*
Head	*284 Feet.*
Storage . . .	*1600 Acre Feet.*
Drainage Area	*400 Square Miles.*
Power House .	*Concrete, 54 ft. × 64 ft.*
Pipe Lines and Canals	*Tunnel, 1000 ft. long, 12 ft. diameter. Forebay 230 ft. steel penstock, 470 ft. long, 7 ft. diameter.*
Generating Equipment	*I. P. Morris turbine 10,000 H.P. direct-connected to 7000 K.W., 6900-volt, 3-phase General Electric generator.*
Transformers .	*Three 2917 K.W., 6900/60,-000-volt, single phase, water cooled.*
Transmission Line	*Connection with Seattle, Tacoma and Everett, over lines of First Snoqualmie Development.*
Use of Power .	*Railway, light and power.*
Operating Company	*Puget Sound Traction, Light & Power Co., Seattle Division.*

PUGET SOUND DISTRICT

UNIV. OF CALIFORNIA

PLATE 23 POND FROM INTAKE—INTAKE FROM DAM—INTAKE TUNNEL SNOQUALMIE

SNOQUALMIE FOREBAY AND SPILLWAY—PENSTOCK—POWER HOUSE PLATE 24

*White River**

(Medium Head)

Location	*24 miles southeast of Seattle, Washington.*
Capacity	*40,000 Horse Power installed. 120,000 Horse Power ultimate.*
Head	*440 Feet.*
Storage	*56,000 Acre Feet.*
Power House	*Concrete, 204 ft. × 82 ft.*
Dam	*Timber crib diverting dam, covered with steel plate, 352 ft. long, 6 ft. high, 61 ft. wide.*
Pipe Lines and Canals	*Eight miles of canals and flumes, 3000 ft. of 12 ft. tunnel. Two steel penstocks, each 2100 ft. long, diameter diminishing from 8 ft. to 6 ft. 6 in. Tailrace canal, 2400 ft. long.*
Generating Equipment	*Two Allis-Chalmers turbines, 20,000 H.P. each, direct-connected to two 10,000 K.W., 6600-volt, 3-phase General Electric generators.*
Transformers	*Seven 3300 K.W., 6600/55,000-volt, single phase, water cooled.*
Transmission Line	*Eight lines, 55,000 volts, 3-phase. Two incoming from Puyallup, 19 miles; one outgoing to Renton sub-station, 18 miles; two outgoing to Seattle, 28 miles; three outgoing to Tacoma, 13 miles.*
Use of Power	*Railway, light and power.*
Operating Company	*Puget Sound Traction, Light & Power Co., Seattle Division.*

**For map see Snoqualmie Section*

White River book, supplied on request, describes work in detail.

WHITE RIVER DIVERSION DAM AND HEADWORKS FROM EAST BANK PLATE 25

PLATE 26 POWER HOUSE WHITE RIVER

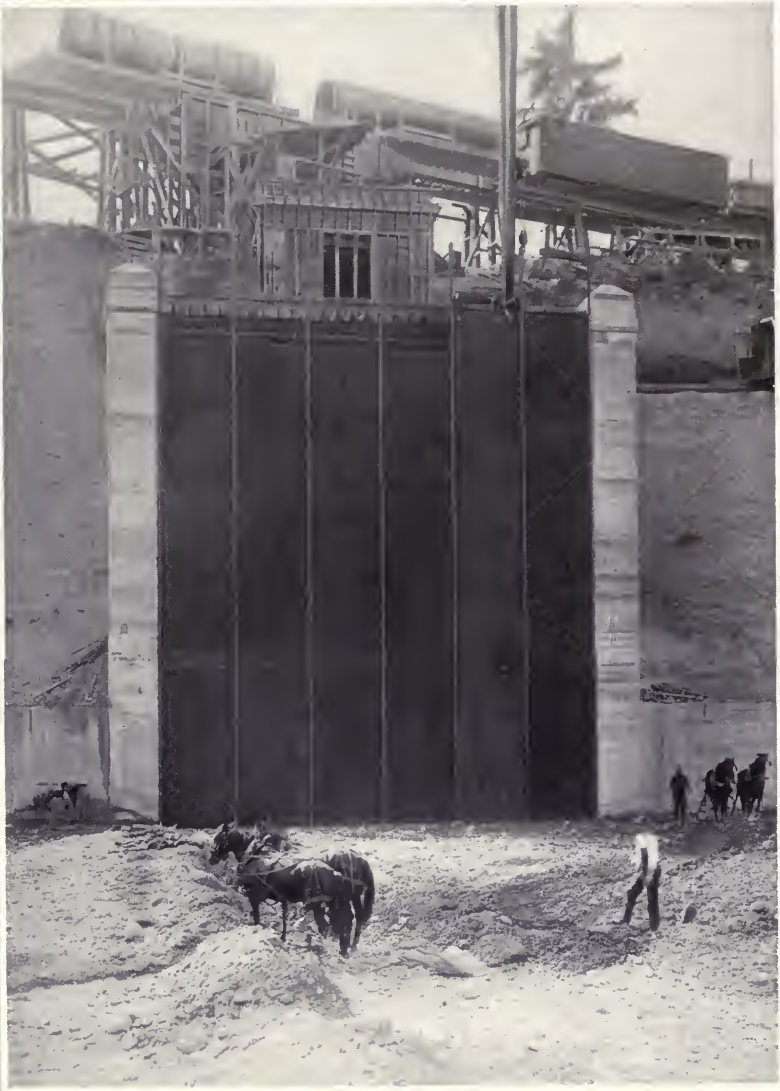
WHITE RIVER REAR OF POWER HOUSE SHOWING AIR CHAMBERS PLATE 27

PLATE 28

LAKE TAPPS, THE

NCIPAL STORAGE WHITE RIVER

PLATE 29 OUTLET CANAL AND FOREBAY, EXCAVATION 558,000 YARDS WHITE RIVER



WHITE RIVER INTAKE OF TUNNEL PLATE 30

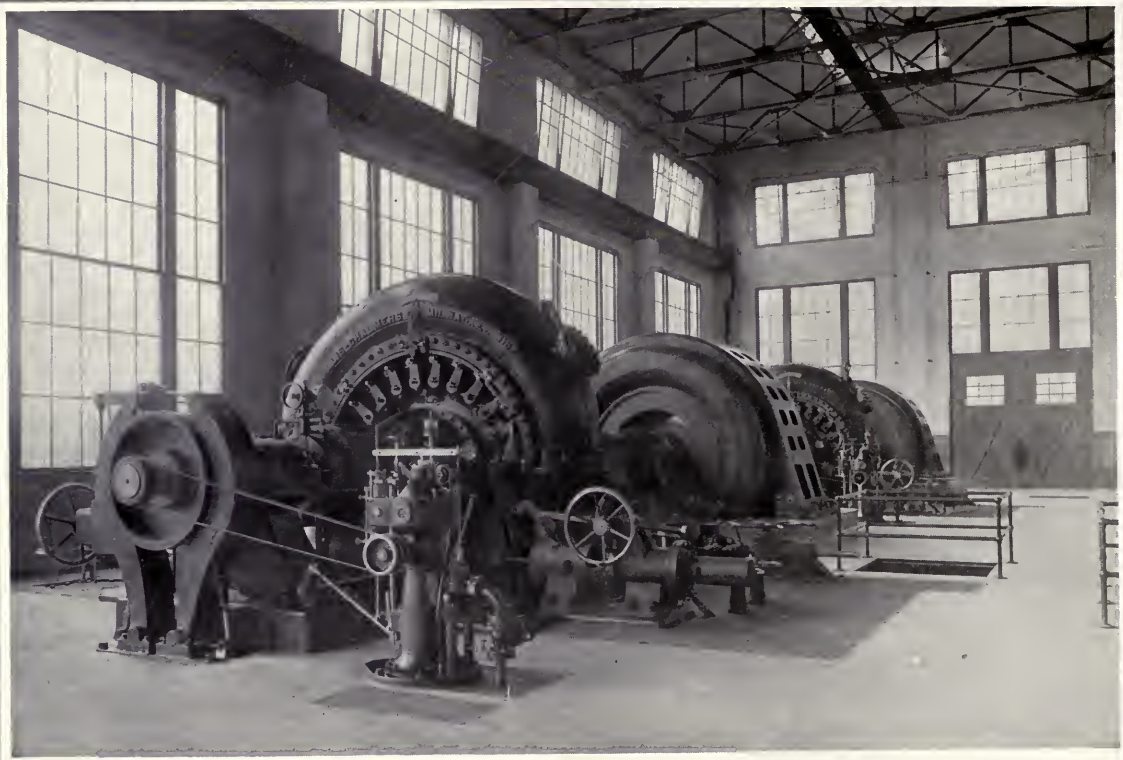
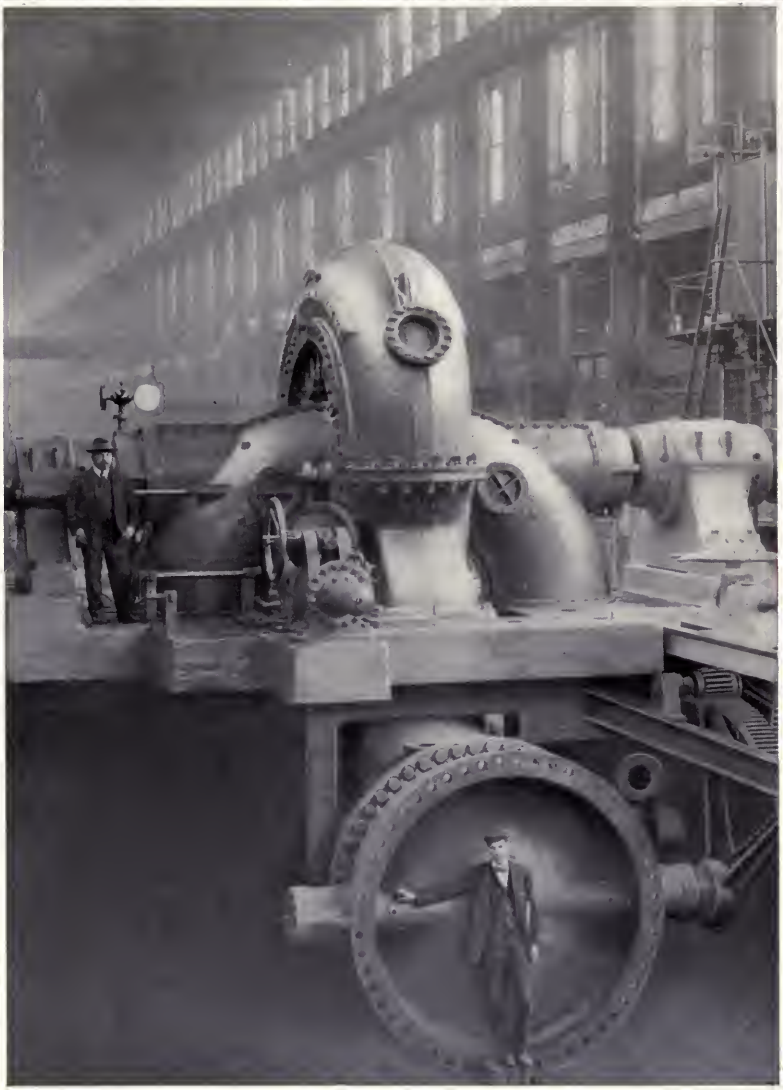


PLATE 31 ONE END OF GENERATOR ROOM WHITE RIVER

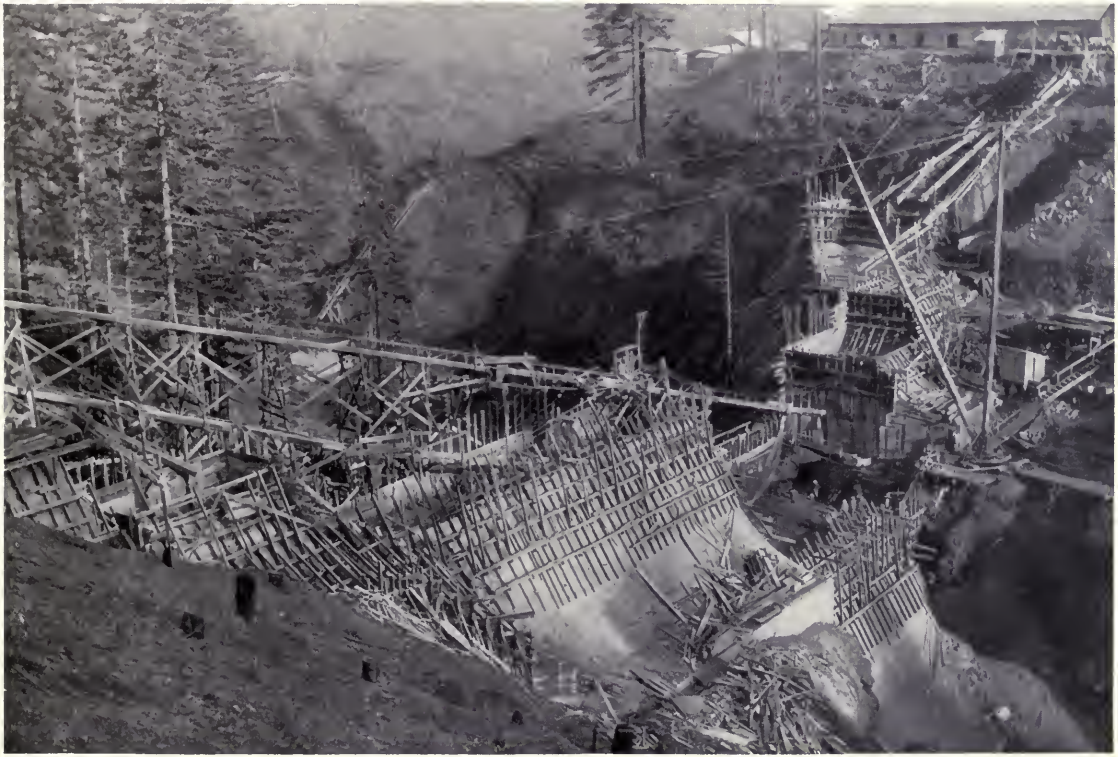


WHITE RIVER ONE OF THE 20,000 H.P. WHEELS PLATE 32

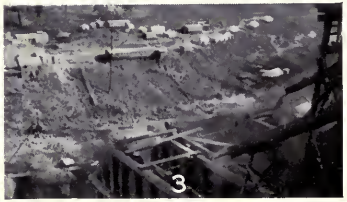
UNIV. OF CALIFORNIA

White Salmon (*Medium Head*)

Location	*White Salmon River, Washington, 75 miles east of Portland, Oregon.*
Capacity	*20,000 Horse Power.*
Head	*175 Feet.*
Pondage	*40,000,000 Cubic Feet.*
Drainage Area	*350 Square Miles.*
Power House	*118 ft. × 55 ft.; concrete, steel frame.*
Dam	*Concrete, solid gravity type, 470 ft. long, 125 ft. high, 250 ft. spillway.*
Pipe Lines	*Flow line, wood stave pipe, 5100 ft. long, 13 ft. 6 in. diameter; concrete forebay. Two pressure pipes 9 ft. diameter, 700 ft. long.*
Generating Equipment	*Two Allis-Chalmers turbines, each direct-connected to a 6000 K.W., 2300-volt, Allis-Chalmers generator.*
Transformers	*Two 2300/66,000-volt, 3-phase.*
Transmission Line	*75 miles of single circuit with provision for double line in future.*
Use of Power	*Light and Power.*
Operating Company	*Northwestern Electric Co.*



WHITE SALMON THE DAM PLATE 33

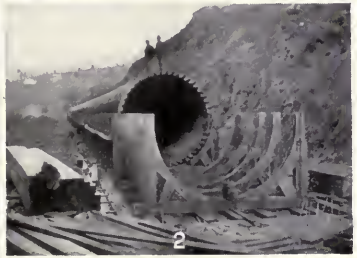


WHITE SALMON CONSTRUCTION

1. The rock crushing and concrete mixing plant extends up the west slope to the quarry, which is over 400 feet above the bed of the river. 2. Engine for hauling rock out of the quarry. 3. Bins receiving sand and rock. 4. In the quarry. 5. Cableways taking cement across. 6. Revolving screens separating sand and rock.

PLATE 34

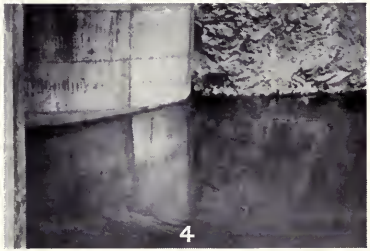
UNIV. OF CALIFORNIA

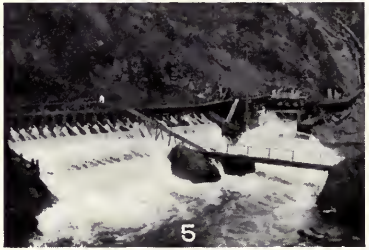


WHITE SALMON CONSTRUCTION

The construction camp and permanent work lie on the east side of the river. 1. Panorama looking east from the top of the rock quarry, above the dam site, and including 1½ miles from the stables and saw mill on the left to the power house site on the right. 2. Section of 13-foot stave pipe. 3. Pipe-line grade looking toward dam-site. 4. Power house superstructure. 5. Saw mill. 6. Power house foundation.

PLATE 35





WHITE SALMON CONSTRUCTION

1. Trucking one of the steel nipples of the penstocks. 2. Skamania Bridge, built to carry equipment to the job. 3. Temporary generator on cableway. 4. Bellmouth of flume receiving the full flow. 5. Spillway of flume above temporary plant. 6. Interior of flume. 7. Dam and flume looking down stream. 8. Dam site before unwatering.

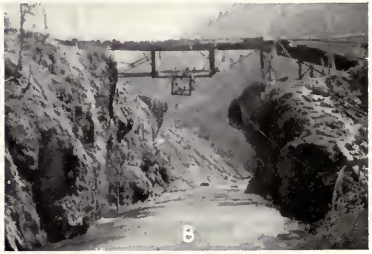


PLATE 36

UNIV. OF
CALIFORNIA

HIGH HEAD PLANTS

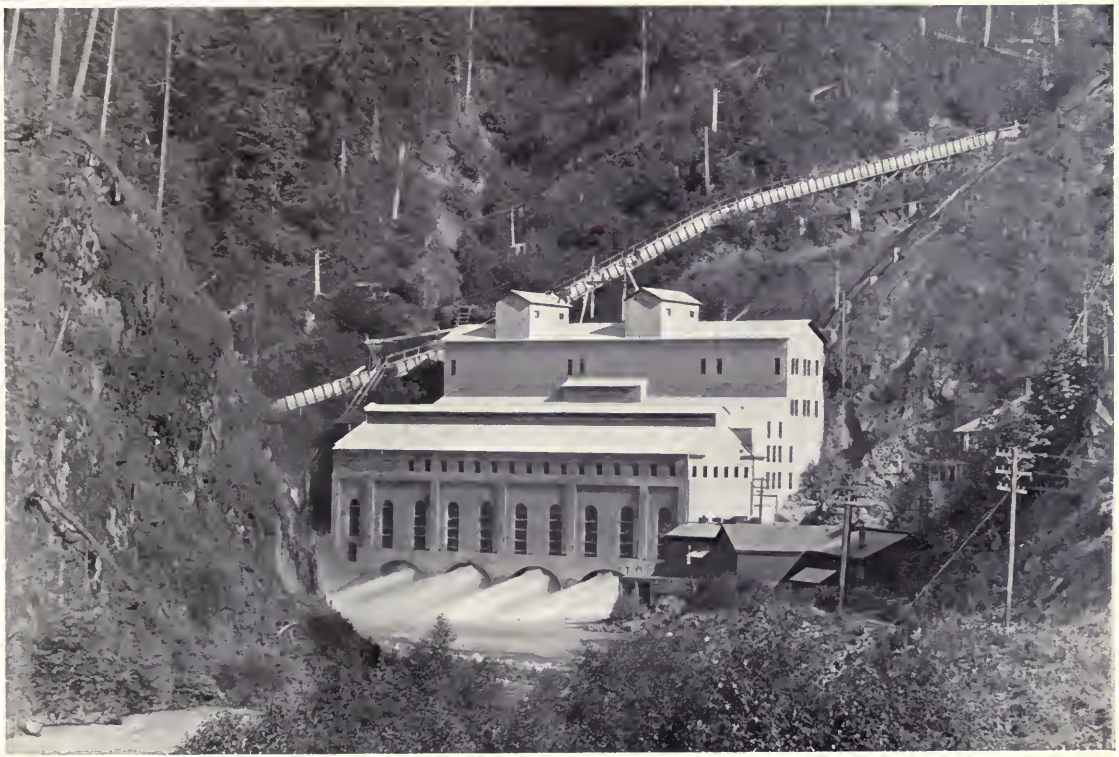
Name	*Constructed for*
Puyallup or Electron . .	*Puget Sound Power Co.*
Big Creek . .	*Pacific Light & Power Corporation*

*Puyallup**

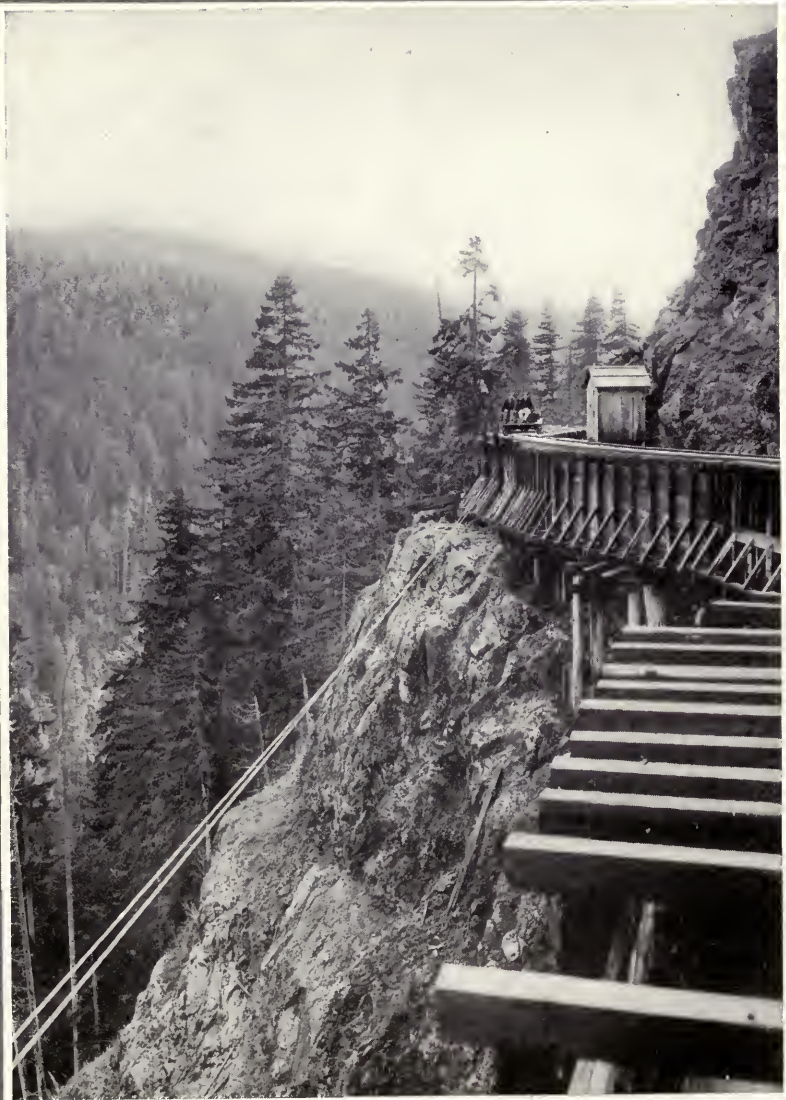
(High Head)

Location	*Puyallup River, 30 miles southeast of Tacoma, Washington.*
Capacity	*18,800 Electrical Horse Power installed. 37,600 Horse Power ultimate.*
Head	*878 Feet.*
Drainage Area	*140 Square Miles.*
Power House	*Concrete, brick and steel, 146 ft. × 95 ft.*
Dam	*Rock filled, timber crib, 200 ft. long, 5 ft. high, 30 ft. wide.*
Pipe Lines and Canals	*10.4-mile flume; four steel penstocks each 1670 ft. long, diameter diminishing from 48" to 36".*
Generating Equipment	*Four twin runner Pelton wheels, 6000 H. P. each, direct-connected to 3500 K.W., 2300-volt, 3-phase General Electric generator.*
Transformers	*Nine 2333 K.W., 2300/55-000-volt, single phase, water cooled.*
Transmission Lines	*55,000-volt, 3-phase, double line into White River Station, 19 miles.*
Use of Power	*Industrial, railway and light.*
Operating Company	*Puget Sound Traction, Light & Power Co., Seattle Division.*

**For map see Snoqualmie Section.*



PUYALLUP POWER HOUSE PLATE 37



PUYALLUP FLUME. 10.4 MILES LONG PLATE 40

PUYALLUP INCLINE RY., 900 FT. ABOVE PLANT PLATE 41

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Big Creek

(High Head)

Location . . *On Big Creek, a tributary of the San Joaquin River, in central California.*

Capacity . . *Initial, 75,000 Horse Power.*
Ultimate, 150,000 Horse Power.

Head . . . *Plant No. 1, 2150 feet.*
Plant No. 2, 1870 feet.

Storage . . *Initial, 38,000 acre feet.*
Ultimate, 100,000 acre feet.

Dams . . . *Four concrete dams, solid gravity type.*
Aggregate length—
Initial, 3000 ft.
Ultimate, 5000 ft.
Greatest height—Initial, 125 ft.
Ultimate, 175 ft.

Pipe Line and Canals *Five miles of 14-ft. tunnel, 6000 feet of 7-ft. flow pipe. Two miles of steel penstocks for initial development, four miles for ultimate development, diameter diminishing from 44" to 26"*

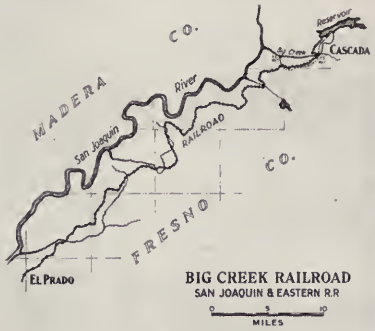
Generating Equipment *Four Allis-Chalmers impulse wheels, 20,000 H.P. each, direct-connected to four 14,000 K.W., 6600-volt generators, two Westinghouse and two General Electric.*

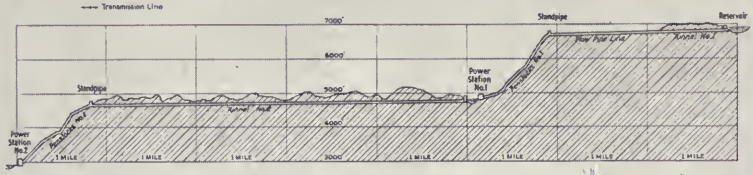
Transformers *Six 5833 K.W., single-phase, 50-cycle, 6600/150,000-volt water-cooled transformers in each plant. Also one spare transformer.*

Transmission Line *Two lines, 150,000 volts, 3-phase, 240 miles to Los Angeles receiving station.*

Operating Company *Pacific Light and Power Corporation.*

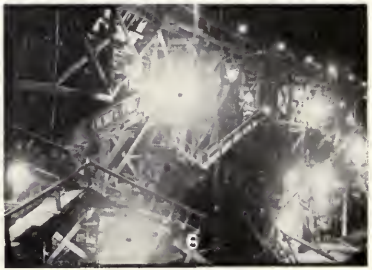
Big Creek reports, supplied on request, describe work in detail.





SECTIONAL VIEW

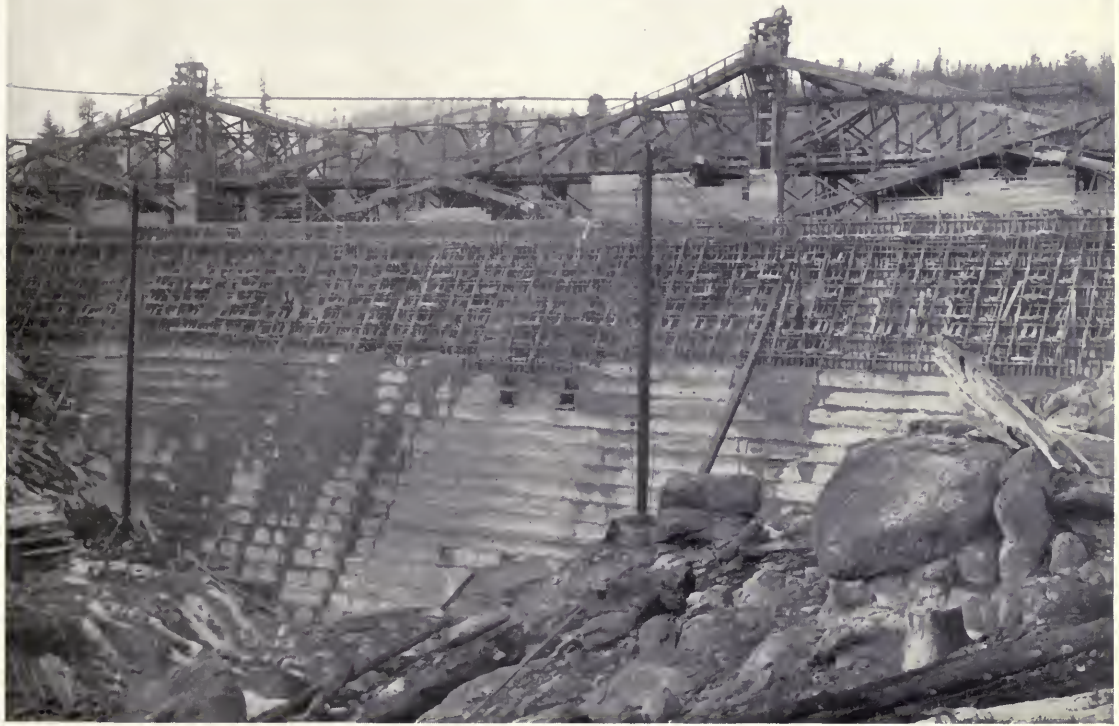
KEY TO BIG CREEK DEVELOPMENT



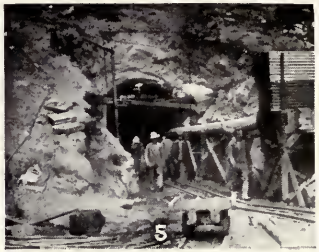
BIG CREEK CONSTRUCTION

1. Basin overlooking sites of three storage dams. Concrete trestle for Dam No. 1 at outlet of the Basin, visible on the left. 2. Type of mixing plant for placing concrete; method devised especially for this job permits concentration of transportation facilities at any given point, thus insuring completion of all the structures in the time available. 3. Steam shovels at work in the gravel pit. 4. Saw mill with capacity of 630,000 feet per month, sawing timber for temporary structures. 5. View on level with initial crest of storage dam showing concrete plant in operation. 6. The job at night.

PLATE 42



BIG CREEK ONE OF THE DAMS, ULTIMATE HEIGHT, 175 FT., LENGTH, 1650 FT. PLATE 43



BIG CREEK CONSTRUCTION

1. Excavation for Power House No. 1, looking west in Big Creek Canyon. 2. Trains passing on the San Joaquin & Eastern Railroad, the construction road which will carry 100,000 tons of material and equipment a distance of 56 miles from the junction with the Southern Pacific Railroad in the valley to elevation 5000 feet. 3. Electric hoist of Incline Railway from terminus of railroad to elevation 7000 feet. 4. Locomotive for the Basin ascending Incline Railway. 5. One of the eight adits or side shafts to tunnel No. 2, permitting rapid boring. 6. Train on San Joaquin & Eastern Railroad near upper terminus. 7. Cars of Incline Railway reaching top of mountain after 2000-foot ascent.

PLATE 44

BIG CREEK TUNNEL, 14 FEET DIAMETER, 4 MILES PLATE 45

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